

***THE HABITAT AND ECOLOGICAL NICHEs OF STAPHYLOCOCCI: A
SCIENTIFIC REVIEW***

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Abstract. Staphylococci (genus Staphylococcus) are widespread Gram-positive bacteria that inhabit humans, animals, and the environment, often acting as

commensals and opportunistic pathogens [2,7]. In mammals, staphylococci physiologically colonize the skin, sebaceous and sweat glands, and the mucous membranes of the nose, oropharynx, intestines, and urogenital tract [2,6,10,16]. *Staphylococcus aureus* permanently or transiently colonizes approximately 20-30% of the human population, predominantly in the nares and on the skin [1,10,14,16].

Keywords: *Staphylococcus*, ecological niches, habitats, microbiota, transmission, antibiotic resistance, reservoirs.

Introduction

The genus Staphylococcus comprises Gram-positive bacteria widely present in humans, animals, and the environment, where they frequently occur as commensals but may also act as opportunistic pathogens [2,7].

Understanding the ecological distribution of staphylococci is important for epidemiology, infection control, and public health.

The aim of this review is to summarize current knowledge about the main habitats and ecological niches of staphylococci in humans, animals, and the environment.

Main reservoirs and ecological niches

Humans and animals

In mammals, staphylococci physiologically colonize the skin, sebaceous and sweat glands, and the mucous membranes of the nose, oropharynx, intestines, and urogenital tract [2,6,10,16].

Staphylococcus aureus permanently or transiently colonizes approximately 20-30% of the human population, predominantly in the nares and on the skin [1,10,14,16].

*In animals (cattle, pigs, poultry, cats, dogs, etc.), staphylococci are widely distributed on the skin and mucous membranes; *S. aureus* is an important pathogen that causes mastitis and other infections, with animals serving as a reservoir for zoonotic transmission to humans [1,4,6,20].*

*Certain ecological groups (e.g., the *S. sciuri* group) persistently colonize animals and humans, including as carriers of virulence and antibiotic resistance genes [8].*

Environment

Due to their resistance to desiccation and temperature fluctuations, staphylococci are found in the air, dust, soil, water, on plants, and on inert surfaces [4,17].

Studies of surface waters show a high diversity of Staphylococcus species and the frequent detection of methicillin-resistant and multidrug-resistant strains of S. aureus and coagulase-negative species [17].

Numerous strains have been identified in seawater and fish, often carrying genes for resistance to dozens of antibiotics and biocides; the spread of these resistant forms is influenced by river runoff and water chemistry [19].

The domestic environment (floors, surfaces, household items) serves as a reservoir for methicillin-resistant coagulase-negative staphylococci, regardless of the presence of pets [15].

Technogenic and food-related niches

In dairy and meat processing facilities, staphylococci are a component of biofilms on equipment and raw materials; S. aureus and S. saprophyticus are often detected in meat, milk, cheese, and other products [3,17,22].

In small dairy farms, S. aureus simultaneously circulates in udders, the farm environment, and cheese, often in the form of methicillin-resistant and enterotoxigenic strains, which creates a risk of foodborne toxicosis [22].

Wild animals and natural ecosystems

S. aureus and other staphylococcal species are widely detected in wild mammals and birds (hares, deer, foxes, rodents, bats, predators, waterfowl, etc.), often as methicillin-resistant strains [4,5].

Surface waters, the marine environment, and fish act as nodes for the transmission of resistant staphylococci between farms, urban environments, and natural biocenoses [3,17,19,23].

Microecological factors in niches

Skin and mucous membranes

The skin - with its dryness, acidic pH, presence of antimicrobial peptides, and constant desquamation of the stratum corneum - creates an environment hostile to many bacteria; nevertheless, S. aureus, S. epidermidis, and other species have adapted to these conditions [10,11,16,18].

The nasal mucosa and skin are characterized by specific combinations of pH, temperature, oxygen, and nutrient content; staphylococci use various regulatory systems to adapt their transcriptome to these conditions in vivo [9,10].

*Analysis of the human skin microbiota has shown that *S. epidermidis*, *S. hominis*, and *S. capitis* are among the most common species [21], with different phylogenetic lineages preferring different types of skin sites (sebaceous, moist, dry) [18,20].*

Selection factors and biotic interactions

Within the skin and mucosal microbiota, staphylococci compete and cooperatively interact with other bacteria and fungi; such interactions determine their abundance and distribution [2,9,12].

*In model biocenoses (cheese rind biofilms), fungi of the genus *Scopulariopsis* selectively stimulate the growth of individual *Staphylococcus* species, which allows weak competitors to dominate the community [12].*

In natural and man-made ecosystems, staphylococci form stable biofilms on solid surfaces (medical devices, equipment, household items), which increases their survivability and promotes the accumulation of resistance genes [3,7,15,17].

Global distribution and climate impact

*Global modeling has shown that the distribution of *S. aureus* is most closely linked to human population density, and that climatic parameters (temperature, precipitation) significantly influence the potential suitability of areas for this species' circulation [13].*

*Under climate change scenarios for 2050-2070, an expansion of zones with favorable conditions for *S. aureus* is predicted, which may contribute to an increased burden of staphylococcal infections in a number of regions [13].*

Staphylococci as "generalists" and a reservoir of resistance

*Some species (e.g., *S. saprophyticus*) demonstrate typical generalism: their strains are almost genetically indistinguishable when isolated from soil, fresh water, food, animals, and humans, which indicates an ability to exist stably in a wide range of environments [23].*

*Groups like the *S. sciuri* group and numerous coagulase-negative staphylococci from the environment carry an extensive set of resistance and virulence genes and are considered a reservoir for clinically significant species, primarily *S. aureus* [3,8,17,19,22,23].*

Conclusion

The habitat of staphylococci encompasses humans, animals, domestic and hospital environments, soil, fresh and marine water, food products, and man-made

surfaces. Their ecological success is determined by their high adaptability to various physicochemical conditions, the ability to form biofilms, and active horizontal transfer of resistance and virulence genes.

Key Habitats and Resistance of Staphylococci

Key Ecological Niches of Staphylococci and Their Significance

Environment/ Reservoir	Main Species and Features	Role in Epidemiology	Citations
Human skin and mucous membranes	<i>S. aureus</i> , <i>S. epidermidis</i> , other commensals	Source of endogenous infections, colonization	[1,2,9,10,16,18]
Domestic and farm animals	<i>S. aureus</i> , the <i>S. sciuri</i> group, numerous <i>CoNS</i>	Zoonotic reservoir, resistance exchange	[1,4,6,8]
Domestic environment	Various methicillin- resistant <i>CoNS</i> and <i>Mammaliococcus</i>	Maintenance of resistant strains outside the hospital setting	[3,15]
Surface and marine waters, fish	<i>S. aureus</i> , <i>S.</i> <i>epidermidis</i> , <i>S. warneri</i> , et al., often MDR	Long-range dispersal, food- related risk	[3,17,19]
Food products	<i>S. aureus</i> , <i>S. saprophyticus</i> , et al., enterotoxigenic and MRSA strains	Foodborne toxic- infections, contact transmission	[17,22,23]

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